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THE PATIENT FLOW OF WOUNDED MARINES WITHIN A MULTI-ECHELON SYSTEM OF CARE

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WITHIN A MULTI-ECHELON SYSTEM OF CARE**

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Summary

Problem

Medical resource planning for combat operations requires projecting the flow of wounded patients from the initial treatment facility on the battlefield, through intermediate care facilities, to hospitals in the continental United States. Such projections require accurate estimations of both the casualty rate and subsequent movement of personnel to advanced levels of care.

Objective

The present investigation seeks to examine the flow of hospitalized Marines through the multi-echelon system of medical care in place during the Vietnam War.

Approach

Hospitalization data covering the 1965 to 1969 era was extracted for Marines who were wounded in action in Vietnam. For those patients seen at an Echelon II or III facility, the inter-echelon movement was tracked until treatment was completed. Inter-echelon movement patterns were also contrasted by different injury types.

Results

Almost half of the admissions to Echelon II facilities and over half of the admissions to Echelon III facilities showed no further treatment at higher echelons of care. Over one fifth of the hospitalized Marines were seen at Echelon IV and more than one third required care at Echelon V (continental U.S.) facilities. Patients with open wounds were most likely to be seen at Echelon II, while those with fractures and head/scalp wounds were most likely to receive treatment at an Echelon III facility. The majority of patients with fractures were eventually treated at Echelon V facilities.

Conclusions

The Vietnam conflict provides military planners with a potentially rich source of information to consider when projecting the needed medical requirements for future combat operations. By combining rate and echelon flow projections with the expected evacuation policies and time needed for treatment, medical resource allocation can be most accurately determined.

THE PATIENT FLOW OF WOUNDED MARINES WITHIN A MULTI-ECHELON SYSTEM OF CARE

Introduction

Allocation of appropriate resources for military medical treatment facilities requires accurate estimates of the number and types of patients that will be seen. During a combat operation, wounded personnel are typically treated and returned to duty or moved rearward for further treatment at higher levels of care. Consequently, forecasting medical resources entails projecting not only the number of personnel that will be injured, but also the flow of patients to intermediate care facilities and to hospitals located in the continental United States. Thus, accurate estimates of both the casualty rate and the percentage of hospitalized patients requiring subsequent movement to facilities offering advanced levels of care will allow planners to determine the most appropriate placement of medical assets to best meet operational demands.

Recent studies have examined the rates of wounded-in-action (WIA) and disease and nonbattle injury (DNBI) incidence of previous combat operations.¹⁻³ Using empirical data, computer models have been built to estimate medical admissions for future scenarios.⁴⁻⁵ Other studies have examined the distribution of specific injuries and illnesses that compose the patient streams.⁶⁻⁷ The objective of the present paper is to analyze the rates and types of injuries seen through a multi-echelon care system during a protracted conflict. Specifically, this paper will examine the flow of U.S. Marine Corps battle injuries through the five-echelon system of medical care in place during the Vietnam War. The number of hospital admissions to treatment facilities in the combat zone first will be computed. Then, the percentages of the admissions that required treatment at each higher echelon will be ascertained to determine the inter-echelon flow rates. Additionally, differences in patient flow by categories of injury conditions will be examined.

The Echelon System of Care

Medical treatment of casualties has traditionally been provided at five different echelons of care.⁸ Echelon I facilities typically have been unit corpsmen or battalion aid stations. Medical personnel

perform first aid and emergency care, control blood loss and shock, and administer antibiotics at these types of facilities.

Echelon II facilities in the past were generally collecting and clearing companies, surgical support companies, and casualty receiving ships. Specifically in the Vietnam War, Echelon II facilities included the 1st and 3rd Medical Battalions and the amphibious landing platform helicopter ships.⁹ Services provided at Echelon II facilities include resuscitative treatment, blood and emergency surgical services, and holding ward facilities.⁸

Echelon III facilities have been represented by hospital ships and combat zone hospitals. These facilities in Vietnam included the Saigon Navy Hospital (later taken over by the Army), the Navy Hospital in Da Nang, and *USS Repose* and *USS Sanctuary* hospital ships.⁹ The Echelon III facilities performed more specialized surgical procedures and offered various clinical capabilities. They provided definitive treatment to those with a reasonable chance of soon returning to duty and immediate, high-level surgical capabilities to those who would require further treatment at yet higher echelons. Hospital admissions for U.S. Marines in the Vietnam War typically began at an Echelon II or Echelon III facility.

Echelon IV treatment centers are overseas medical facilities, usually fully staffed hospitals, designed to give definitive or specialty care to those personnel who could not receive the necessary procedures of care at Echelon II or III facilities that would allow them to return to duty. The principal Echelon IV facilities for the Marines during the Vietnam War were the naval hospitals in Yokosuka, Japan, and the Marianas Islands.

Echelon V facilities are in the continental U.S. (CONUS) and are designed to provide convalescent, restorative, or rehabilitative services. The Echelon V facilities for the Marines who served in Vietnam were primarily CONUS naval hospitals.

Method

WIA incidence data were extracted from hospitalization records of Marines who served in Vietnam during the 1965 to 1969 period. Records were selected that showed an initial treatment at an Echelon II or Echelon III facility in Vietnam. The movement of each patient was tracked through the various levels of echelon care during the course of the hospitalization. Hospitalization records showing movement to a facility whose echelon level could not be determined were removed (0.64%), as were those with unusual and, therefore, questionable movement patterns between echelons (0.17%).

During this time frame, there were 33,073 individuals representing 39,175 WIA hospitalizations and 115,552 diagnoses. The majority of Marines, and therefore the bulk of the Navy medical resources, were deployed in the northern part (I Corps) of South Vietnam. Consequently, initial treatment of the seriously wounded or injured Marines from other parts of the country was occasionally provided by Army and Air Force units.⁷ Such transfers from non-Navy facilities represented 3.7% of the total WIA hospitalizations entering the Navy treatment system at the Echelon II or III level. The levels of treatment required by all patients reaching a Navy Echelon II or III facility (n = 39,175) and the contrasting levels of care needed by patients with different types of injuries are the focus of this study.

Results

Inter-Echelon Patient Movement

Tables 1 and 2 summarize the inter-echelon patient movement for wounded personnel whose initial hospitalization occurred at Echelons II and III, respectively. Table 1 shows the movement of the 20,626 WIA hospitalizations that received initial treatment at an Echelon II facility. Presented in this table is the number of patients admitted at each echelon during the course of treatment and the level to which they were subsequently moved.

**Table 1. Inter-Echelon Movement of Marines Wounded in Action
and Initially Hospitalized At Echelon II; Vietnam 1965-1969**

<u>Level of Care</u>	<u># of Patients</u>	<u>No Further Treatment Recorded</u>	<u>Subsequent Level of Care</u>			
			<u>Echelon II</u>	<u>Echelon III</u>	<u>Echelon IV</u>	<u>Echelon V</u>
Echelon II	20,626	48.0%	-----	14.4%	19.2%	18.4%
Echelon III	2,975	53.4%	1.2%	-----	24.6%	20.8%
Echelon IV	4,689	49.3%	-----	-----	-----	50.7%
Echelon V	6,796	100.0%	-----	-----	-----	-----

Of the total 20,626 WIA hospitalizations commencing at Echelon II, 4,689 of the patients were received at an Echelon IV facility. Of these 4,689, almost half did not require treatment beyond Echelon IV, with the balance (50.7%) transferred to an Echelon V facility. Of the original Echelon II admissions, 6,796 patients (32.9%) were eventually seen at an Echelon V facility. There were also isolated instances of "backward" movement of patients between echelons, usually from Echelon III to Echelon II. Of the patients moved from Echelon III, there were 36 cases (1.2%) of a patient again receiving treatment at Echelon II.

Table 2 depicts the WIA hospitalizations that initiated at an Echelon III facility and is similar in format to Table 1.

**Table 2. Inter-Echelon Movement of Marines Wounded in Action
and Initially Hospitalized At Echelon III; Vietnam 1965-1969**

<u>Level of Care</u>	<u># of Patients</u>	<u>No Further Treatment Recorded</u>	<u>Subsequent Level of Care</u>			
			<u>Echelon II</u>	<u>Echelon III</u>	<u>Echelon IV</u>	<u>Echelon V</u>
Echelon III	18,549	51.5%	1.4%	-----	23.3%	23.8%
Echelon II	263	57.8%	-----	10.3%	14.4%	17.5%
Echelon IV	4,359	39.8%	-----	-----	-----	60.2%
Echelon V	7,077	100.0%	-----	-----	-----	-----

Table 3 summarizes the information from Tables 1 and 2. It presents the percentage of WIA patients received at each echelon of care, both for those who began their hospitalization at Echelon II and those

who began at Echelon III. For example, for all patients who started at an Echelon II facility, 14.4% were eventually seen at an Echelon III facility, 22.7% at an Echelon IV facility, and 32.9% at an Echelon V facility. Depending on the location in the theater and the nature of the injury, as well as other operational considerations, some echelons were often “leapfrogged” in the treatment process. The extent of “echelon-skipping” is shown in Table 4.

Table 3. Percentage of Overall Hospitalizations Treated at Each Echelon for Marines Wounded in Action in Vietnam, 1965-1969

	<u>Initial Hospitalization at Echelon II</u>	<u>Initial Hospitalization at Echelon III</u>	<u>All Hospitalizations</u>
Echelon II	(100.0%)	1.4%	53.3%
Echelon III	14.4%	(100.0%)	54.9%
Echelon IV	22.7%	23.5%	23.1%
Echelon V	32.9%	38.2%	35.4%
Number of Patients	20,626	18,549	39,175

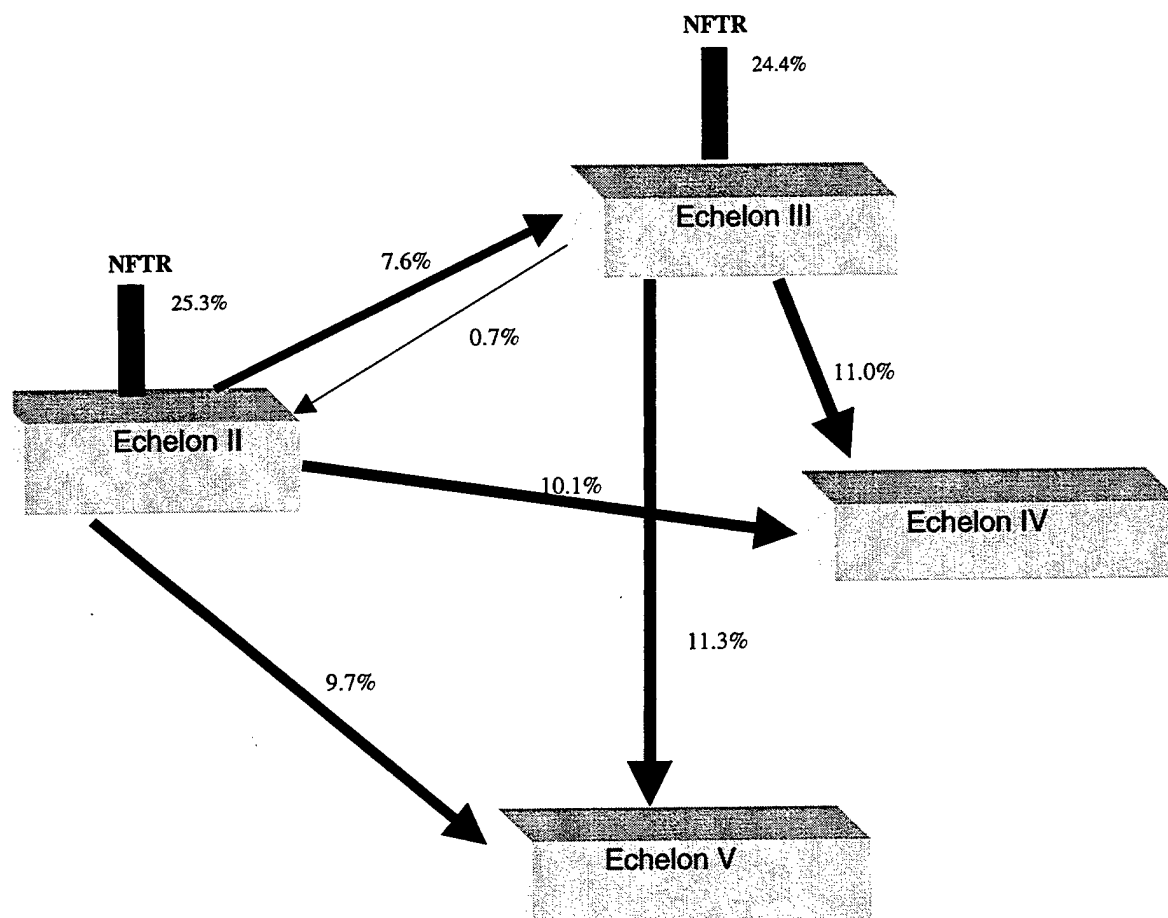
Table 4 shows detailed information on the various patient movement patterns for the 39,175 WIA hospitalizations. The most frequently recorded patient flow for a wounded Marine in Vietnam was to be seen at Echelon II and have no further treatment recorded at other echelons; the second most frequent was to be seen at Echelon III and not have any additional treatment recorded. These two combined represented the outcome for 49.7% of the 39,175 hospitalizations. The next six most frequent patient flows all involved individuals being initially hospitalized at an Echelon II or III facility and then being moved out of Vietnam to an Echelon IV or V facility. This group represented another 42.1% of the total WIA hospitalizations. Movement from an Echelon III to an Echelon V facility was the most prevalent of these six patient flows, constituting 11.3% of the total.

Table 4. Inter-Echelon Patient Movement of Marines Wounded in Action, All Diagnoses

Patient Treatment Flow				Patient Treatment Flow		
<u>Rank</u>	<u>by Echelon</u>	<u>N</u>	<u>%</u>	<u>by Echelon</u>	<u>N</u>	<u>%</u>
1	2	9,895	25.3%	For Initial Hospitalization at Echelon II		
2	3	9,556	24.4%	2	9,895	25.3%
3	3-5	4,409	11.3%	2-3	1,588	4.1%
4	2-5	3,798	9.7%	2-4	1,989	5.1%
5	3-4-5	2,605	6.6%	2-5	3,798	9.7%
6	2-4	1,989	5.1%	2-3-2	36	0.1%
7	2-4-5	1,969	5.0%	2-3-4	322	0.8%
8	3-4	1,716	4.4%	2-3-5	620	1.6%
9	2-3	1,588	4.1%	2-4-5	1,969	5.0%
10	2-3-5	620	1.6%	2-3-4-5	409	1.0%
11	2-3-4-5	409	1.0%	For Initial Hospitalization at Echelon III		
12	2-3-4	322	0.8%	3	9,556	24.4%
13	3-2	152	0.4%	3-2	152	0.4%
14	3-2-5	46	0.1%	3-4	1,716	4.4%
15	2-3-2	36	0.1%	3-5	4,409	11.3%
16	3-2-3	27	0.1%	3-2-3	27	0.1%
17	3-2-4	21	0.1%	3-2-4	21	0.1%
18	3-2-4-5	17	0.0%	3-2-5	46	0.1%
				3-4-5	2,605	6.6%
				3-2-4-5	17	0.0%
	Total	39,175	100.0%			

Figure 1 portrays the initial movement for the 39,175 WIA hospitalizations. Only the first movement, if any, after the initial Echelon II or III hospitalization is displayed in this graph. Figure 2 displays percentages corresponding to each type of inter-echelon movement for the 19,724 initial Echelon II and III admissions that required further treatment. As patients often move more than once, Figure 2 portrays both the initial and subsequent movements between differing treatment echelon levels.

Fig. 1. Movement to Secondary Treatment Level Following Initial Entry to Echelon II or Echelon III Medical Facilities; U.S. Marines Wounded in Action in Vietnam, 1965-1969

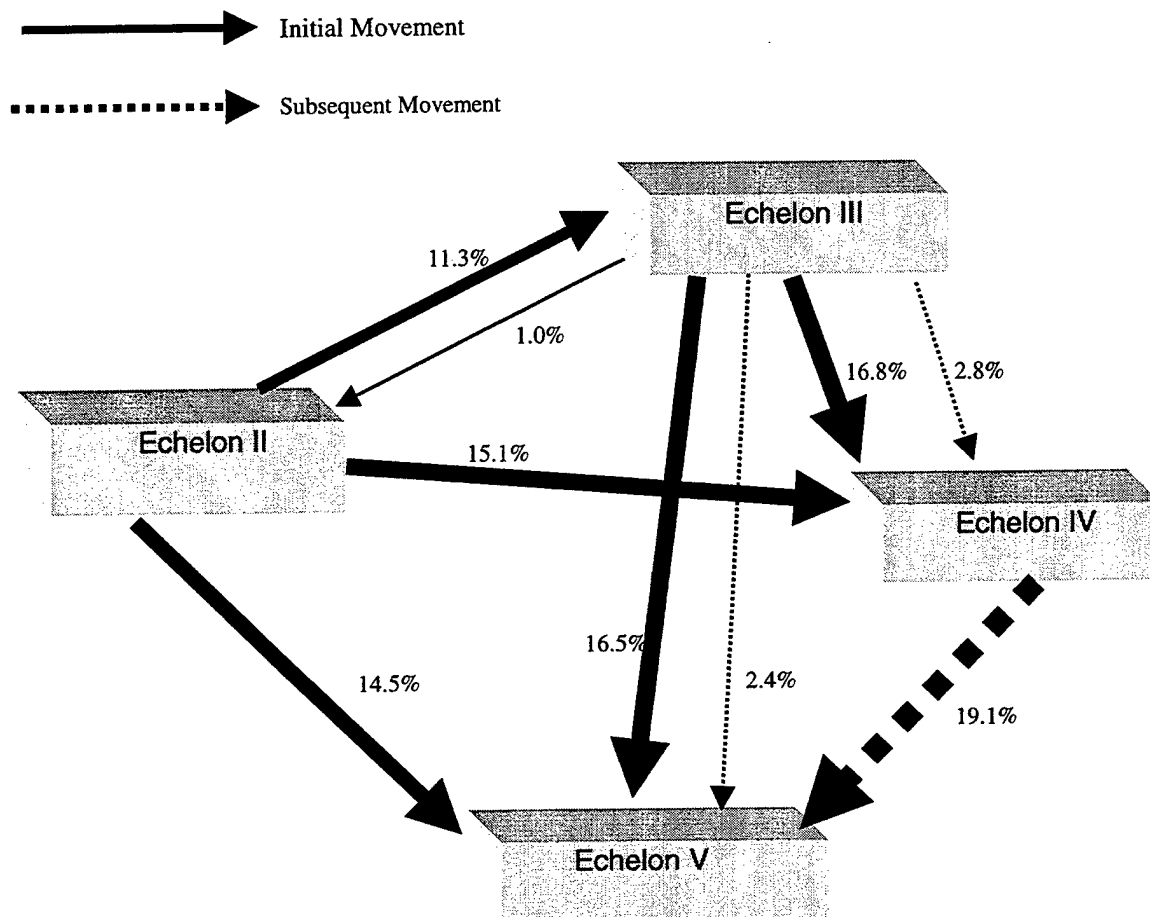


NFTR - no further treatment recorded

Note A - the percentages are based on 39,175 WIA hospitalizations during this period. For example, there were 7.6% x 39,175 or 2,975 hospitalizations that started at Echelon II and moved to Echelon III.

Note B - the percentages do not reflect intra-echelon movement, or the movement from one facility to a different facility at the same echelon level.

Fig. 2. Initial and Subsequent Inter-echelon Flow of U.S. Marines Wounded in Action in Vietnam, 1965-1969



Echelon flows representing less than 1% of the total hospitalizations are omitted.

Note A - the percentages are based on 19,724 WIA hospitalizations with 26,222 interechelon movements during this period. For example, there were 11.3% x 26,222 or 2,975 cases of initial patient movement from Echelon II to Echelon III, and 19.1% x 26,222 or 5,000 cases of secondary patients moving from Echelon IV to Echelon V.

Note B - the percentages do not reflect intra-echelon movement, or the movement from one facility to a different facility at the same echelon level.

Intra-Echelon Patient Movement

The intra-echelon flow, or movement between facilities at the same echelon of care among the WIA casualties, is summarized in Table 5. For instance, 189 patients showed one movement from an Echelon II facility to another Echelon II facility, while 7 other patients recorded two such movements between Echelon II facilities.

Table 5. Summary of Intra-Echelon Movements of Marines Wounded in Action

<u>Echelon Level</u>	<u>Transferred once</u>	<u>Transferred twice</u>	<u>Transferred 3+ times</u>	<u>Total</u>
Echelon II	189	7	0	196
Echelon III	1,213	23	5	1,241
Echelon IV	18	0	0	18
Echelon V	425	20	1	446
Total	1,845	50	6	1,901

Of the 39,175 total WIA hospitalizations, 1,901 cases showed intra-echelon movement (4.9%). Most of these cases involved only one move to a facility at the same echelon level before moving to another level. However, 56 cases had two or more moves at the same echelon level before returning to duty or going to another echelon of care. Altogether, there was a total of 1,963 intra-echelon movements. The vast majority of the intra-echelon transfers occurred either at Echelon III (65.0%) or Echelon V (23.8%).

Results by Injury Type

Accurate medical planning requires an assessment of patient flow by injury type. Certain types or categories of injuries may be more resource-intensive than others or may be more likely to require a higher level of care. The following tables present the distribution of primary injury types for the WIA casualties, and display the patient flows among the most prominent injury groupings.

Table 6 shows the primary injury-type diagnoses for the 39,175 WIA hospitalizations. Also shown in Table 6 are secondary diagnoses recorded within 10 days of the initial admission. More than three fourths of all the primary diagnoses were open wound injuries. Open wounds, fractures, and head/scalp wounds combined to represent 90.9% of the primary WIA diagnoses and 59.2% of the secondary WIA diagnoses.

Table 6. Frequency of Occurrence of WIA Injury Types

<u>Injury Type</u>	<u>Primary Diagnosis</u>		<u>Secondary Diagnosis within</u>	
	<u>At Admission</u>		<u>10 Days of Admission</u>	
	<u>#</u>	<u>%</u>	<u>#</u>	<u>%</u>
Fracture	4,521	11.5%	3,453	19.0%
Dislocation	75	0.2%	201	1.1%
Sprain	422	1.1%	286	1.6%
Head/Scalp Wound	1,599	4.1%	1,685	9.3%
Injury	737	1.9%	941	5.2%
Open Wound	29,483	75.3%	5,601	30.9%
Amputation	1,031	2.6%	403	2.2%
Superficial Injury	117	0.3%	366	2.0%
Contusion	424	1.1%	636	3.5%
Foreign Body	59	0.2%	279	1.5%
Burn	560	1.4%	315	1.7%
Nerve Injury	77	0.2%	2,202	12.1%
Adverse Effects	4	0.0%	404	2.2%
Toxic Effects	6	0.0%	11	0.1%
Ill-Defined Symptoms	60	0.2%	1,361	7.5%
Total	39,175	100.0	18,144	100.0

Table 7 presents the most frequently recorded patient flows among casualties with an injury type of open wound, fracture, and head/scalp wounds. Some distinct differences can be seen in the patient flows for these three types of primary injury categories. Open wounds were more likely to be treated at Echelon II facilities than were fractures and head/scalp wounds. Fractures were most likely to require treatment at an Echelon IV or V facility, while treatment of head/scalp wounds was most often confined to Echelon III.

**Table 7. Patient Treatment Flow Comparisons for the Most Common
Primary Injury Types - Marines Wounded in Action**

Patient Treatment Flows	Open Wounds	Fractures	Head/Scalp Wounds
2	28.9%	7.5%	22.7%
2-3	4.8%	1.0%	2.0%
2-4	6.0%	3.0%	0.6%
2-5	10.0%	13.3%	1.0%
2-3-5	1.8%	1.0%	0.6%
2-4-5	5.4%	6.1%	0.4%
3	23.3%	17.2%	51.4%
3-4	4.2%	6.1%	2.1%
3-5	8.1%	26.3%	12.1%
3-4-5	4.8%	16.9%	5.3%
Others	2.7%	1.6%	1.8%
Total	100.0%	100.0%	100.0%

Table 8 further summarizes the patient treatment flows for each of the three primary injury groups. The percentages of patients seen at each echelon level are shown for the three groups. Of the patients with a diagnosis of open wounds, 59.6% of them were seen at some point at an Echelon II facility, while 49.7% of them were seen at some point at an Echelon III facility. This can be contrasted with those personnel with fractures, of which only 33.5% were seen at an Echelon II facility, but 70.1% were seen at Echelon III. The percentages in each group add up to over 100% since many patients were seen at more than one echelon level.

**Table 8. Percentage of Wounded Marines Treated at Each Echelon
by Primary Injury Type**

<u>Open Wounds</u>		<u>Fractures</u>		<u>Head/Scalp Wounds</u>	
<u>Echelon</u>		<u>Echelon</u>		<u>Echelon</u>	
II	59.6%	II	33.5%	II	29.0%
III	49.7%	III	70.1%	III	75.3%
IV	22.5%	IV	33.2%	IV	9.4%
V	31.3%	V	64.5%	V	20.1%

Table 9 presents the distribution of primary injury categories by echelon level. Distinct differences in the type of injury being treated can be seen among the echelons. Of those patients seen at Echelon II, 84.1% were treated for open wounds, while only 7.2% had a primary diagnosis of fractures. In contrast, 21.0% of the wounded personnel treated at Echelon V facilities were seen for fractures.

Table 9. Percentage of Patients by Primary Injury Type Treated at Each Echelon

<u>Injury Type</u>	<u>Echelon II</u>	<u>Echelon III</u>	<u>Echelon IV</u>	<u>Echelon V</u>
Open Wounds	84.1%	68.1%	73.3%	66.5%
Fractures	7.2%	14.7%	16.6%	21.0%
Scalp/Head	2.2%	5.6%	1.7%	2.3%
Other	6.4%	11.5%	8.5%	10.2%
Total	100.0%	100.0%	100.0%	100.0%
	(20,889)	(21,524)	(9,048)	(13,873)

Conclusion

With many times more battle injuries sustained in the Vietnam War than any other U.S. combat operation in the last 40 years, this conflict provides military planners with a potentially rich source of information to consider when projecting the medical requirements needed for future extended combat operations. The present paper examined the most common patient flows of Marine WIA patients through

the various echelons of medical care, the percentage of patients who reached each level of echelon care, and the differences in course of treatment by various types of injury categories. Key findings showed that almost half of the initial admissions to Echelon II and III had no further treatment recorded at higher echelons of care, and that 42.1% of the WIA patients were evacuated from their initial echelon of hospitalized treatment to an Echelon IV or Echelon V facility outside of Vietnam. Other results showed that almost one quarter of all WIA admissions eventually required treatment at Echelon IV and that over one third eventually required treatment at Echelon V.

Accurate overall casualty rate forecasting, as well as reliable projections of the types and severity of wounds are critical in determining the medical resources needed to support a combat operation. Earlier studies formed the basis for rate projections in differing combat scenarios.^{2,4} The present investigation provides information on the movement of wounded casualties through the various levels of echelon care. By combining casualty rate and echelon flow projections with the expected evacuation policies and lengths of treatment, medical resource allocation throughout a multi-echelon system of care may more accurately be determined.

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